



Welcome to the Sciences and Exploration Directorate!

Dr. Colleen Hartman
Director, Sciences and Exploration Directorate





Agenda

Who we are

What we do

How we do it

Why we do it

Quick Facts About SED



Largest Earth and Space Science Research organization in the world

Located in Greenbelt, New York and Wallops Flight Facility with 2640 people:

543 Civil servants including ~400 Scientists

~600 Co-located Post-Docs and University Scientists

~1,500 Support Contractors, Visitors, Students, Emeritus, and other staff



Goddard Space Flight Center's Sciences and Exploration Directorate members have received worldwide accolades for their work.



Dr. Piers Sellers

Most Excellent
Order of the British Empire
2011
Honors for services to science.



Dr. John Mather

Nobel Prize in Physics
2006
Rumford Prize 1996 Franklin Medal 1999



Dr. Mather is the recipient of more than 30 honors in the physical sciences.

Dr. Compton Tucker

Galathea Medal - Denmark 2004
Vega Medal - Sweden 2014
in Physical Geography



The Intergovernmental Panel on Climate Change (IPCC) was awarded the Nobel Peace Prize in 2007 for its work on climate change, together with former US Vice-President Al Gore. Over 50 scientists from the Goddard Space Flight Center contributed to the IPCC Assessments that formed the basis for the award.





Agenda

Who we are

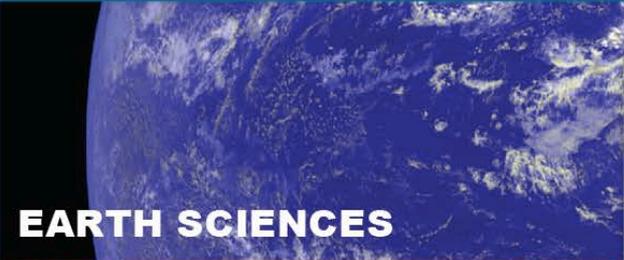
What we do

How we do it

Why we do it

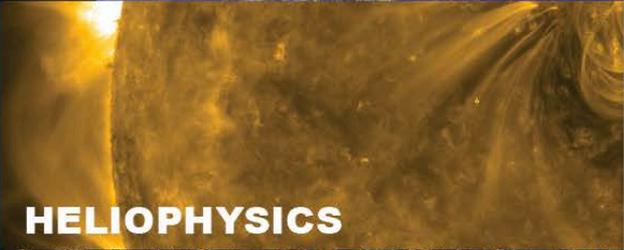


Goddard Begins and Ends with Science



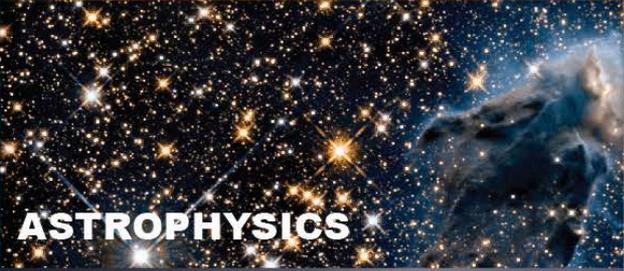
EARTH SCIENCES

- How does the Earth – atmosphere, ice, oceans, land, humans – work?
- How do we humans impact the climate?
- How will the Earth's climate evolve in the future?



HELIOPHYSICS

- How does the sun work?
- When does space harm us?
- How to live within a star's atmosphere?



ASTROPHYSICS

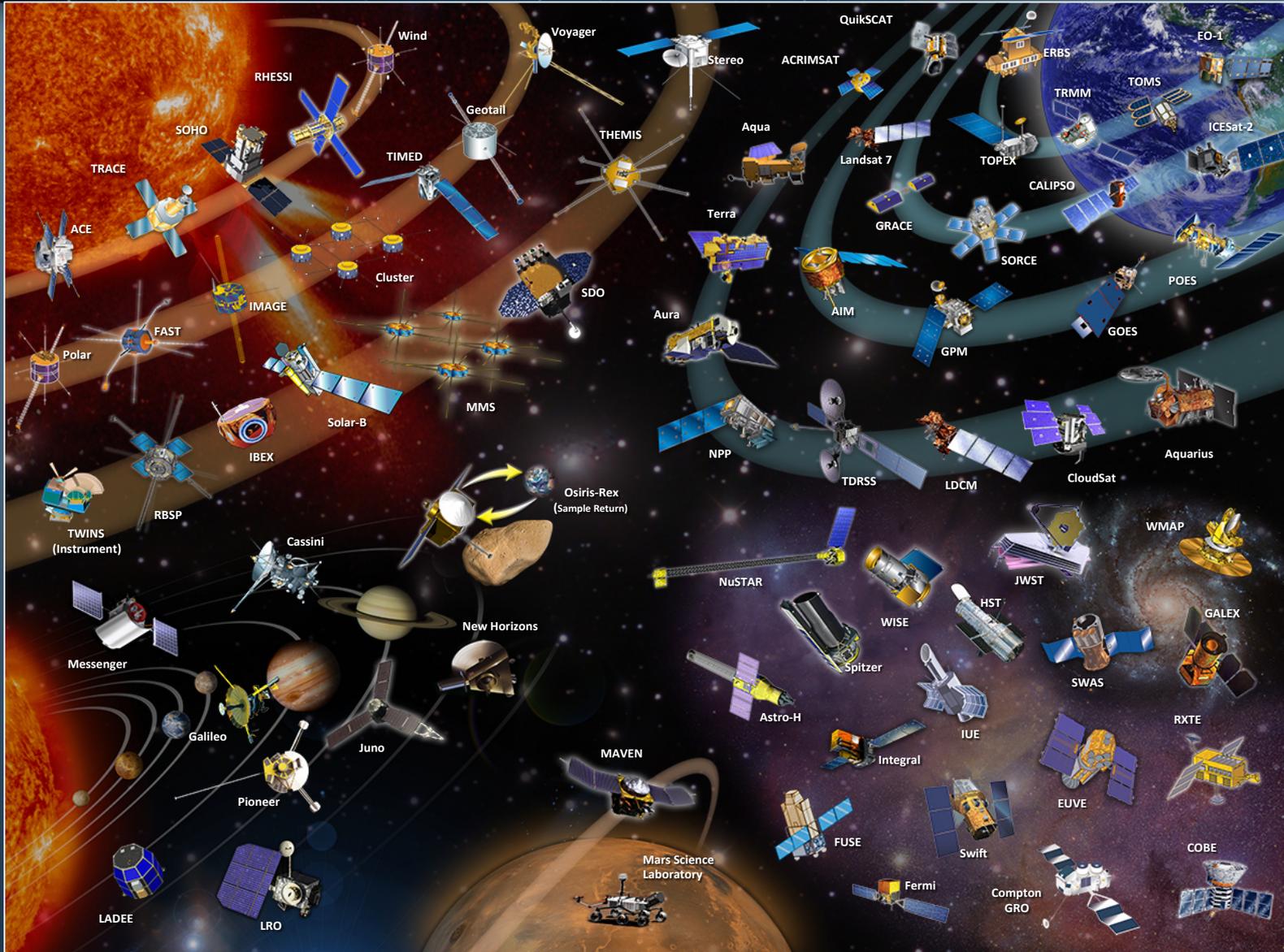
- How does the universe work?
- Where did we come from?
- Are we alone?



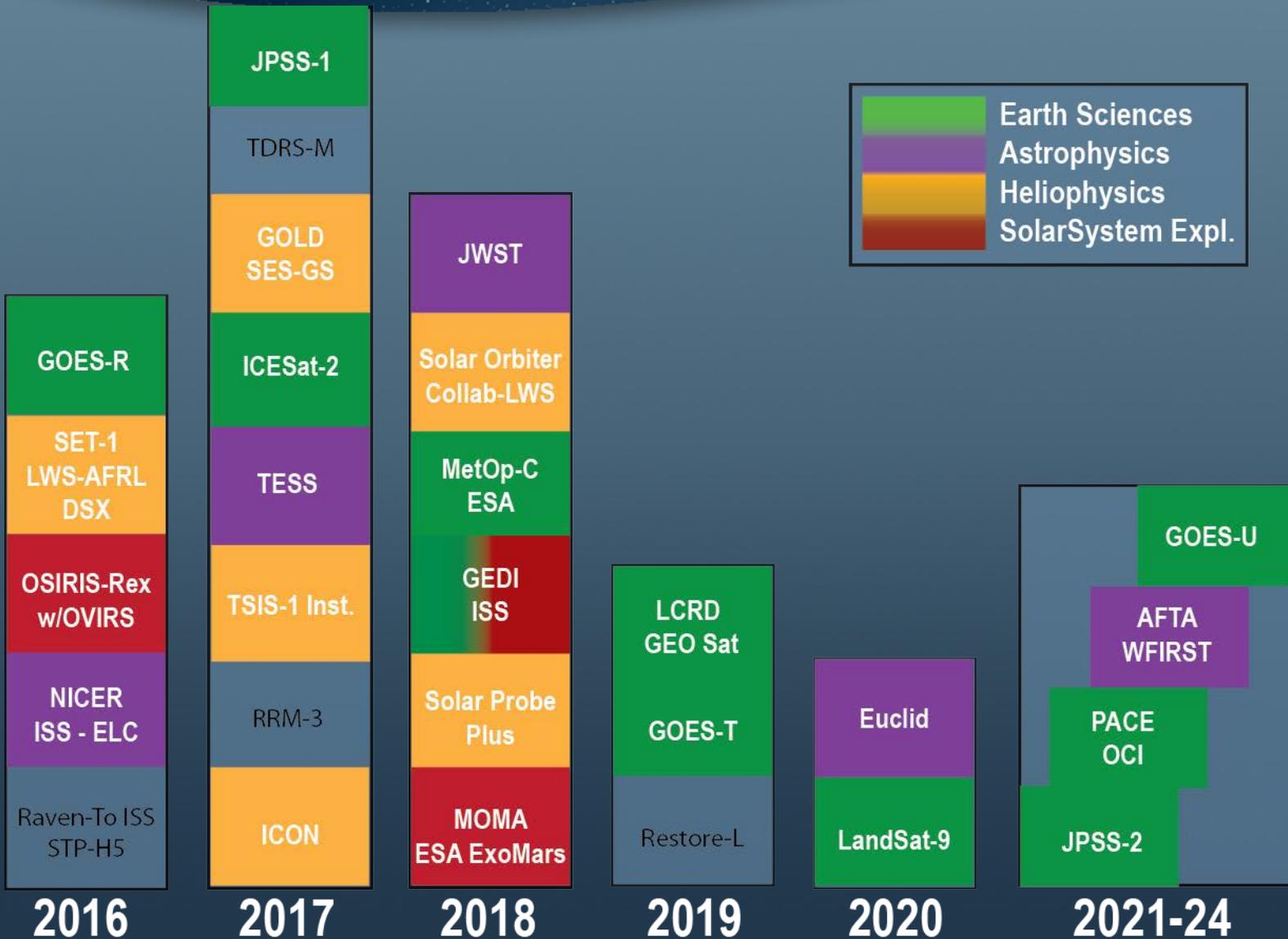
SOLAR SYSTEM

- How did our solar system form and evolve?
- Can we find evidence of life elsewhere in the solar system?
- What are the different environments and processes in our solar system?

GSFC: A Diverse Mission Portfolio



Upcoming Launches





Agenda

Who we are

What we do

How we do it

Why we do it

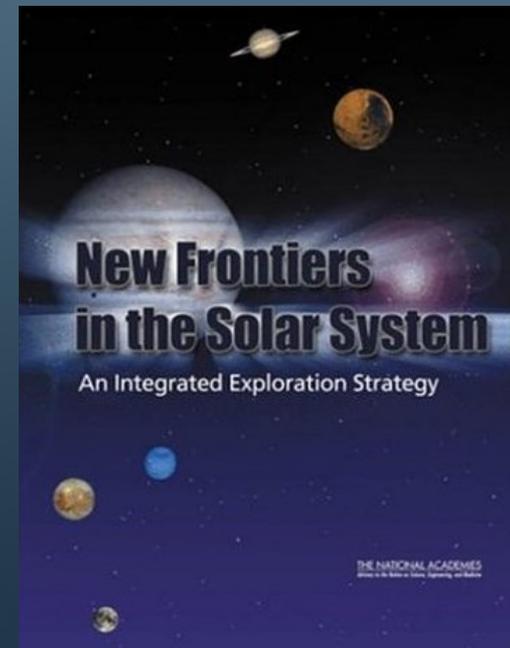
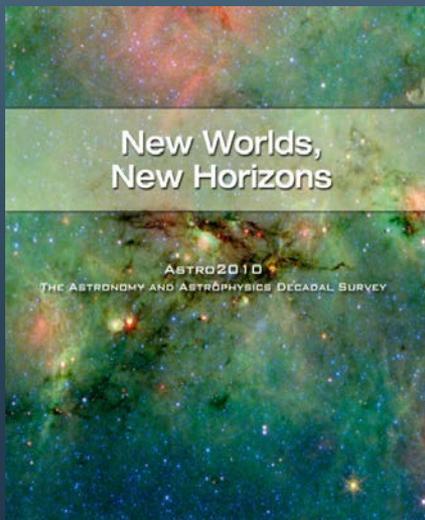
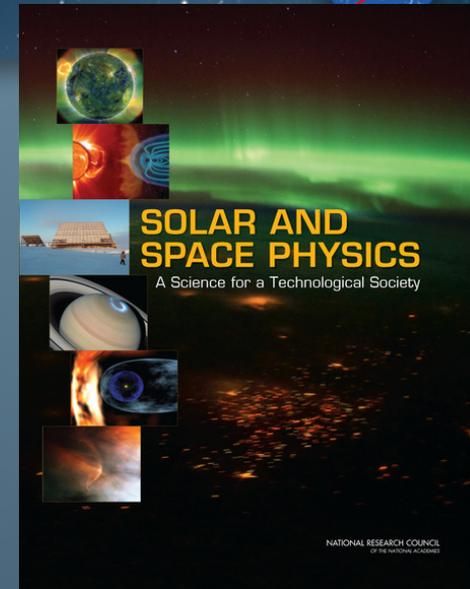
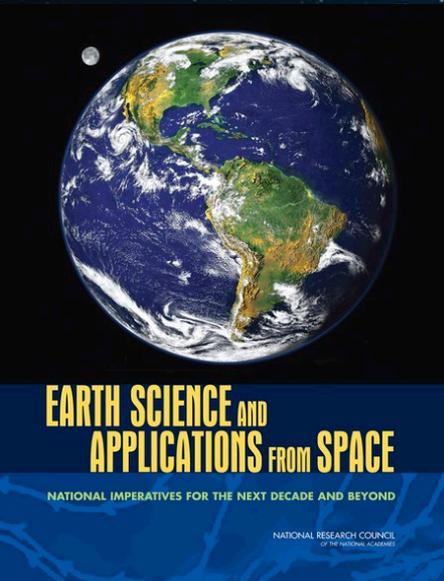
Decadal Surveys



Strategic missions usually are >\$1B and are prioritized by the NAS every 10 years through a Decadal Survey process engaging the entire community to reach a consensus on highest priorities

Smaller, more directed science missions are typically competed via AO's and are cost capped e.g. Explorer, Discovery, New Frontiers, Venture Class

GSFC partners with scientists at universities and other government labs to undertake these missions – we must be customer orientated!



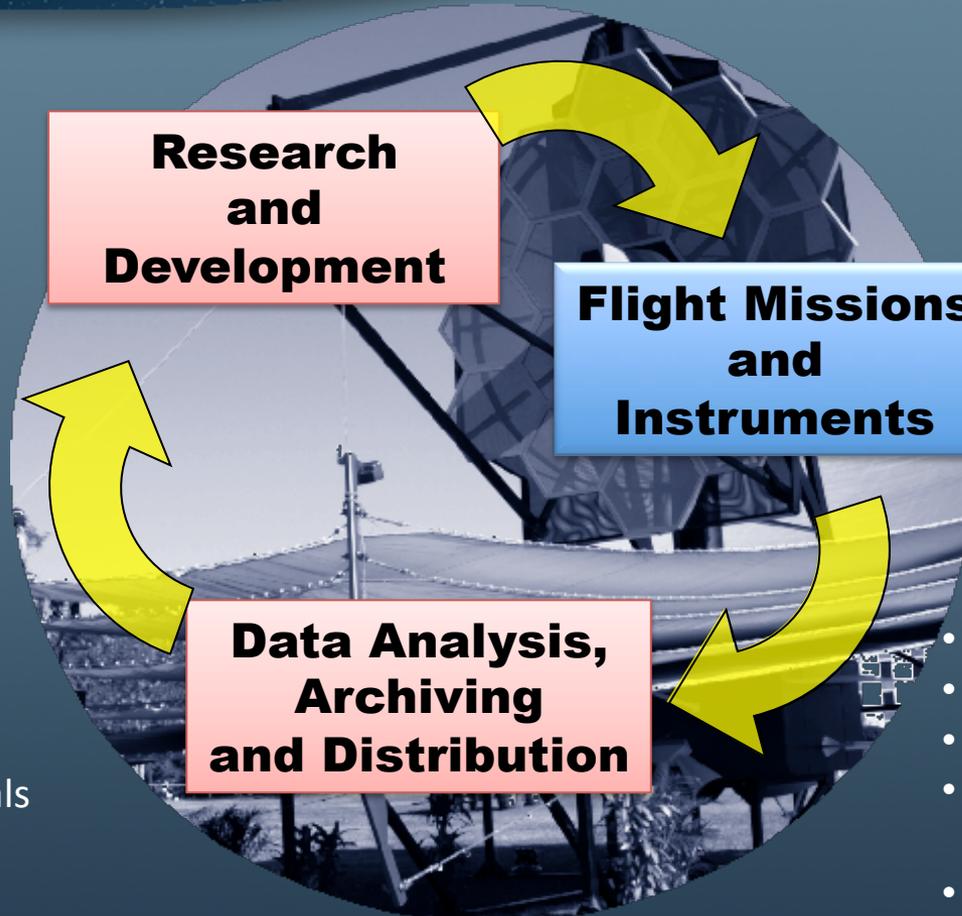
Sciences and Exploration Directorate



SED provides scientific *leadership* and *stewardship* for space-based studies of the Earth, the Sun-Earth interaction, the Solar System, and the Universe through partnership with the scientific community to achieve NASA's science goals

- **Project Scientists** ensure that mission scientific goals are defined and realized, who participate in all aspects of the project management and oversight, and who represent the project to the science user community
- **Principal Investigators** conceive missions, instruments or investigations, assemble and lead teams to propose and implement the effort, and who are accountable for its success
- **Scientific research and technology development** in partnership with the engineering directorate and the scientific community enables future missions, make new discoveries, advance knowledge and benefit society
- **Data modeling and science data centers** maximizes the scientific return of hundreds of GSFC managed missions and instruments by providing freely accessible calibrated data, analysis software, and advanced modeling to the scientific community and the public
- **Public Outreach** widely communicates NASAs science program and inspire the next generation of scientists

The Mission Cycle



Flight Programs Leads

SED Leads

- Lab experiments
- Technology Development
- Theory / Modeling
- Field Studies
- Concept Development

- Observation Proposals
- Data Archives
- Applications
- Long-Term Modeling
- Data Products

- Project Management
- Project Science
- Engineering
- Fabrication, Integration & Test
- Mission Design & Development
- Launch & Operations

Funding of Research at NASA



- GSFC science research is driven by community peer review in a full and open competition with goals set by Decadal Surveys
- NASA scientists must write proposals as Principal Investigators and compete with the external science community for research funds, *including the funds that pay their salaries*
- There is also internal competition for center IRAD funds, as well as B&P to support proposal efforts
- Directed work is only related to project science and other service activities (equivalent to teaching at a University)

There is a lot of proposal writing in code 600!



Agenda

Who we are
What we do
How we do it
Why we do it



Goddard Begins and Ends with Science

Fundamental Questions

- How does the universe work?
- Where did we come from?
- Are we alone?

Current Missions

HST,
SWIFT,
FERMI,
XMM

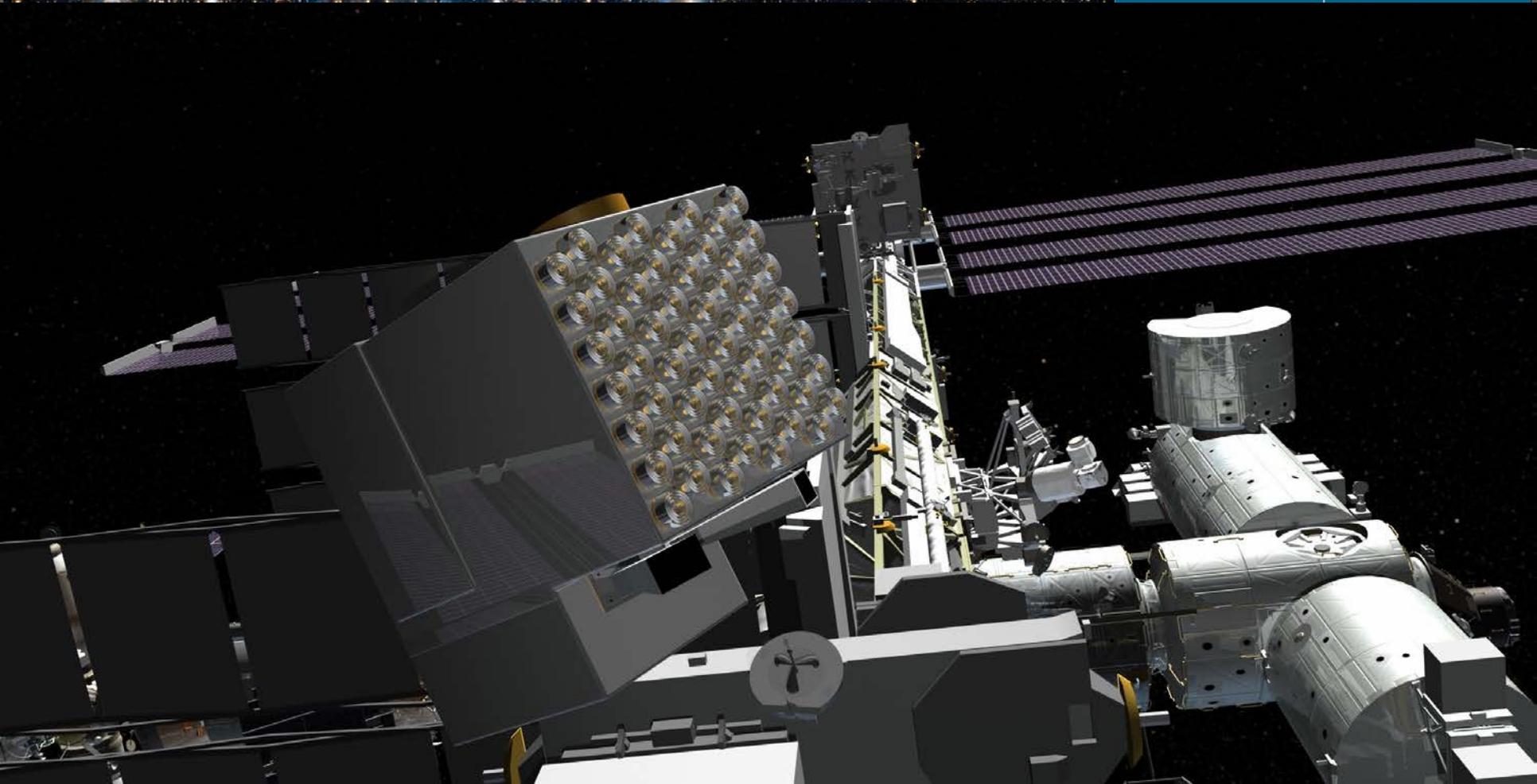
In Development

TESS, JWST
PIXIE, Litebird
ETA, WFIRST, NICER,
TESS BETTII, AdEPT
Other MIDEX and
SMEX

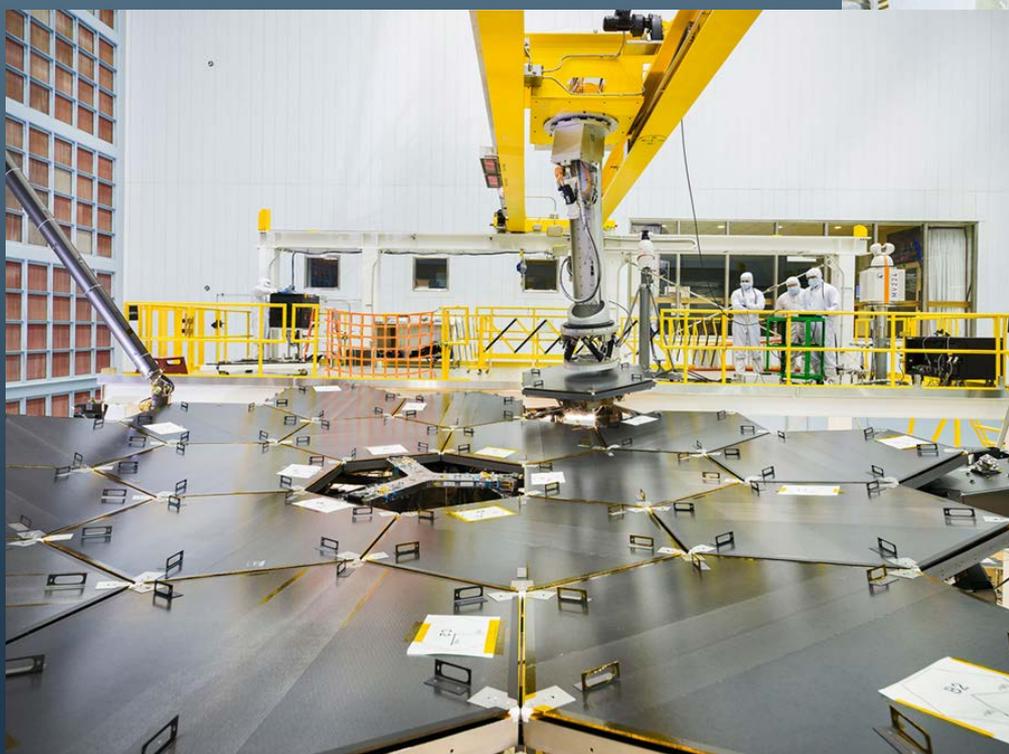
10 Year Horizon

LUVIOR
FIR Flagship
WFIRST
ESA L3
MIDEX, SMEX

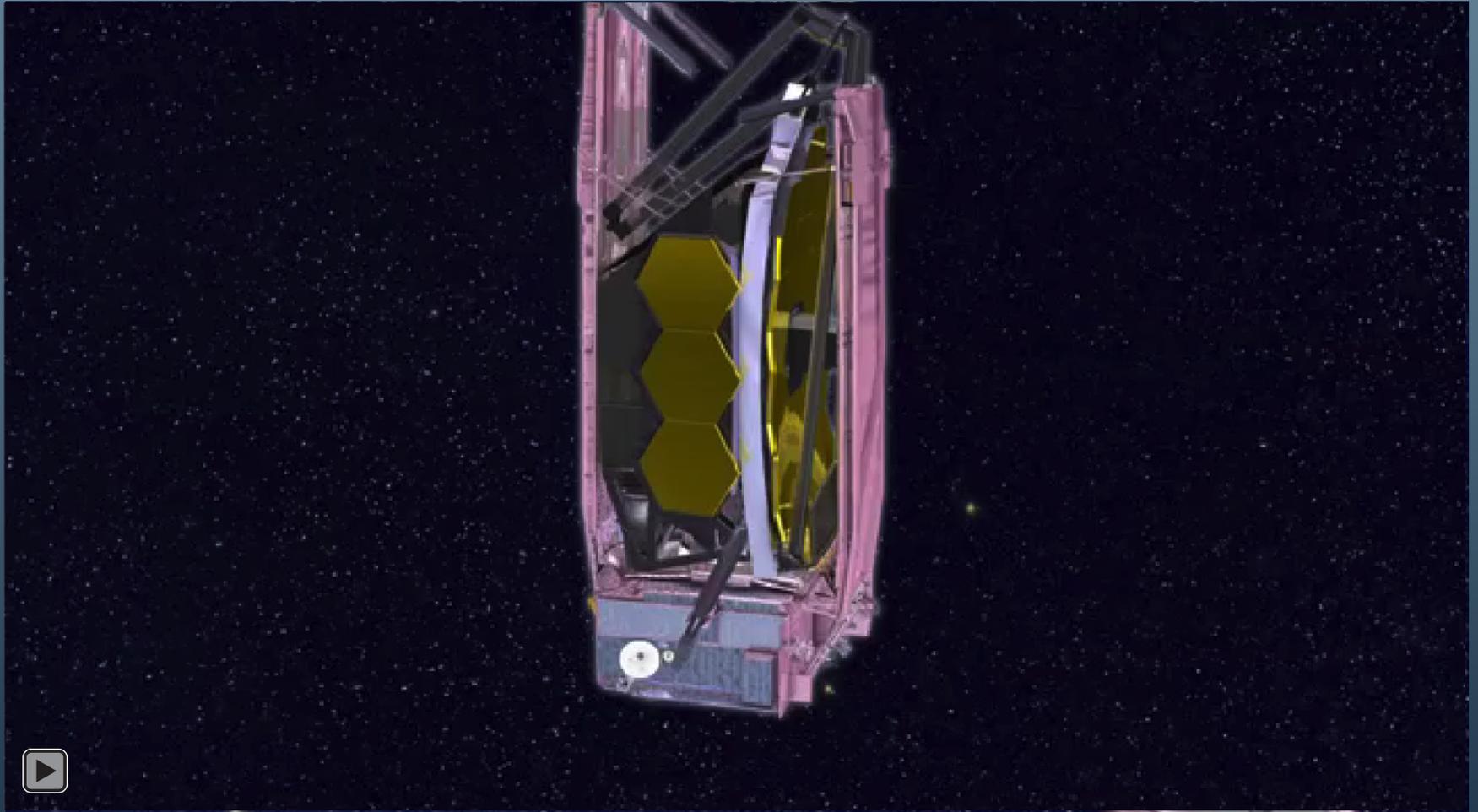
ASTROPHYSICS



JWST mirrors delivered and Installed at GSFC



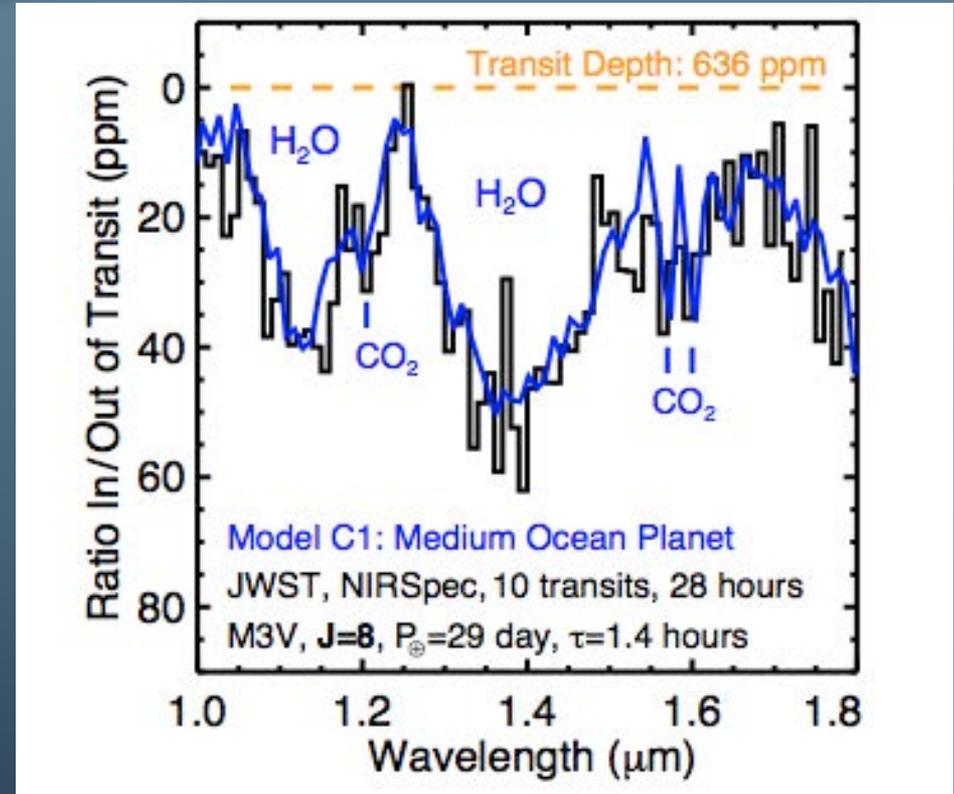
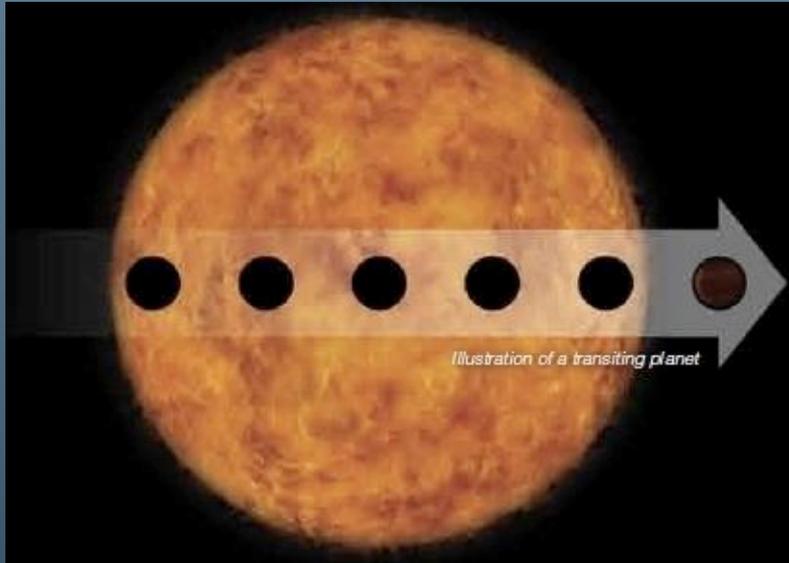
James Web Space Telescope Origami



JWST Exoplanet Studies



JWST Science Themes – The Origins of Life

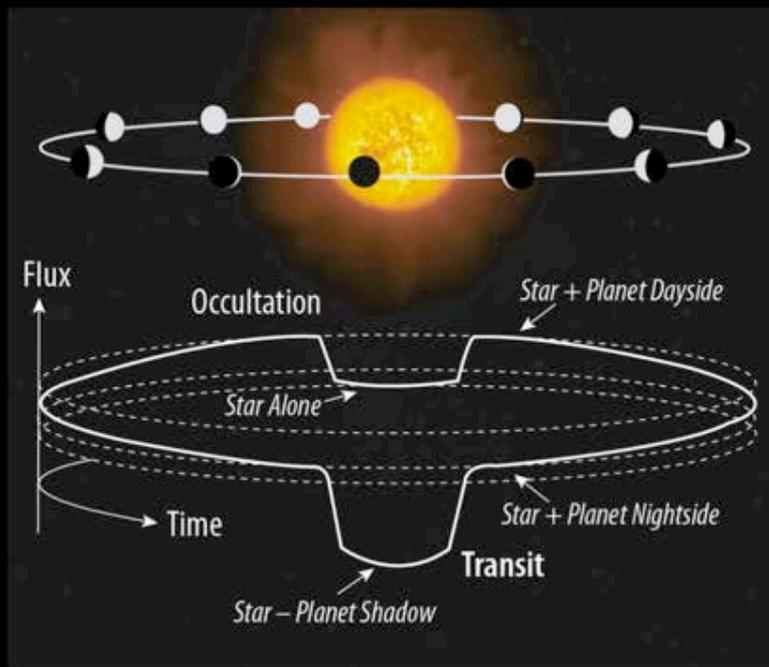


Simulated JWST observations of an Ocean planet half the mass of the Earth orbiting an M3V star

Water and CO₂ features are detectable in the NIRSpec instrument

TESS Science Goals and Drivers

PI George Ricker MIT



Discover Transiting Earths and SuperEarths orbiting Bright, Nearby Stars

- Rocky planets
- Water worlds
- Habitable zone planets

Discover the “Best” ~1000 Small Exoplanets

All Sky Survey of Bright Stars

- F, G, K dwarfs: 4 to 12 magnitude
- M dwarfs known within ~60 pc
- 500,000 stars in two years

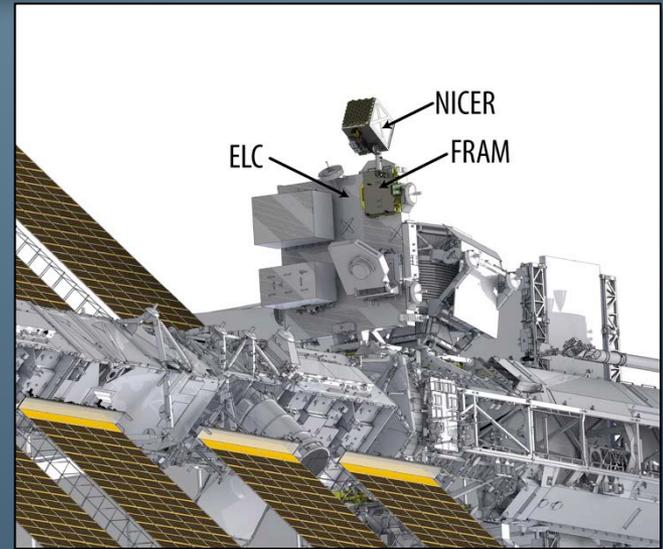


Neutron star Interior Composition ExploreR



PI: Keith Gendreau

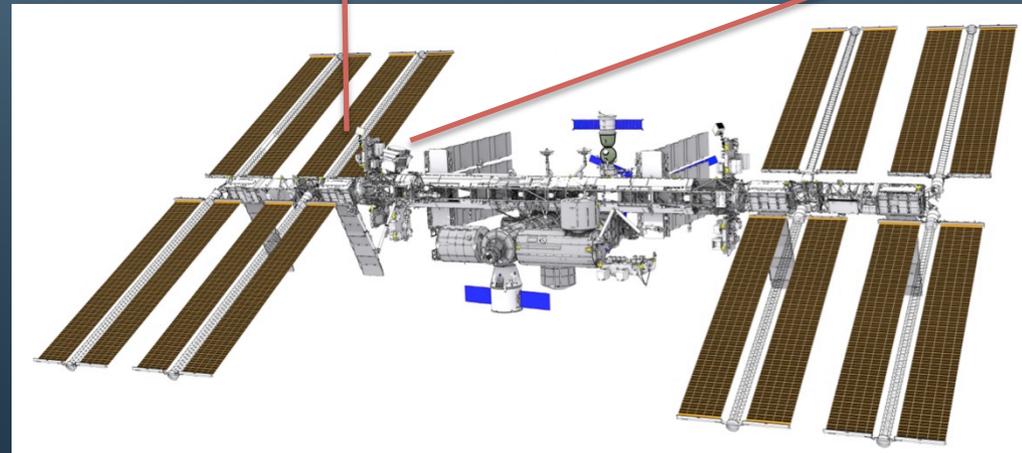
- **Science:** Neutron stars
- **Launch:** Late 2016
- **Instrument:** X-ray (0.2–12 keV) “concentrator” optics and silicon-drift detectors with 300 ns time tagging
- Demonstration of pulsar-based navigation



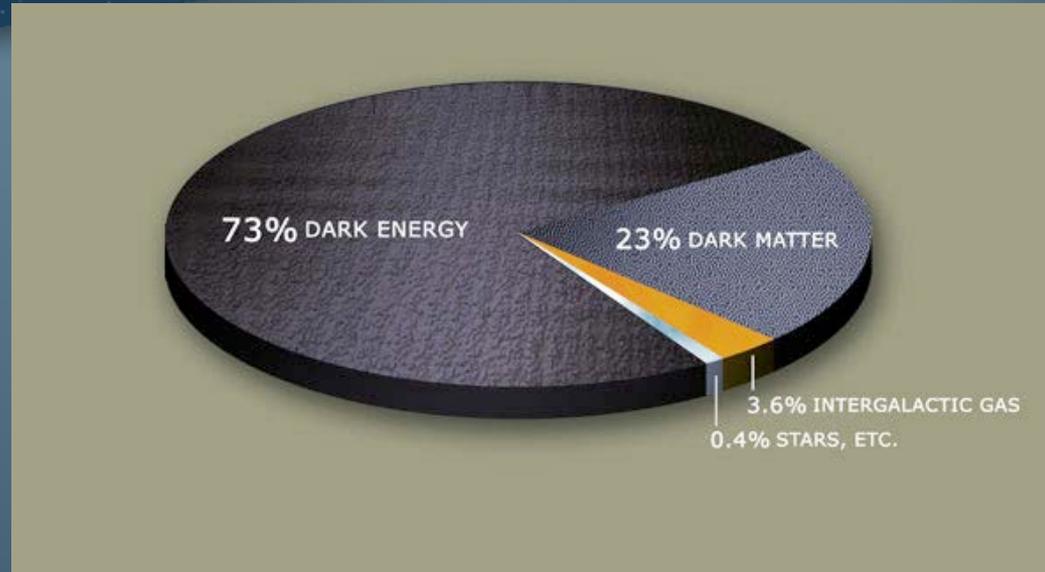
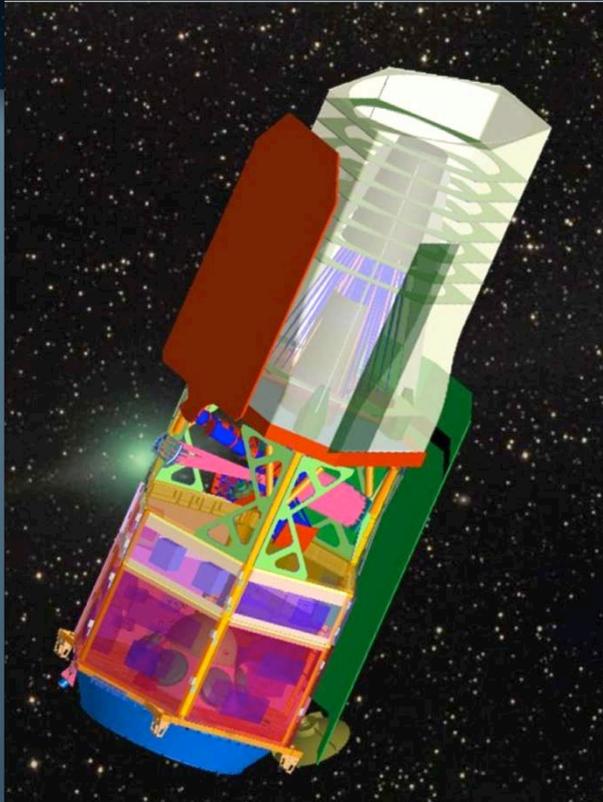
A neutron star: What happens when you pack more than 1.4 solar masses into something the size of New York City?



Credit: NASA/MSEFC



WFIRST – Dark Energy and Exoplanets



Wide Field Infra-Red Survey Telescope – WFIRST

Large scale surveys of the sky in the infra-red

Precisely measure the expansion and geometry of the Universe to study Dark Energy

Search for Extra-solar planets

Different implementation options being studied for launch in ~2023



Goddard Begins and Ends with Science

Fundamental Questions

- How does the Earth – atmosphere, ice, oceans, land, humans – work?
- How do we humans impact the climate?
- How will the Earth's climate evolve in the future?

Current Missions

NOAA-19, Suomi-NPP, GOES-13, 14, & 15, DSCOVR, Landsat 7, 8, EOS-Terra, Aqua, Aura, GPM, SMAP, CATS (ISS)

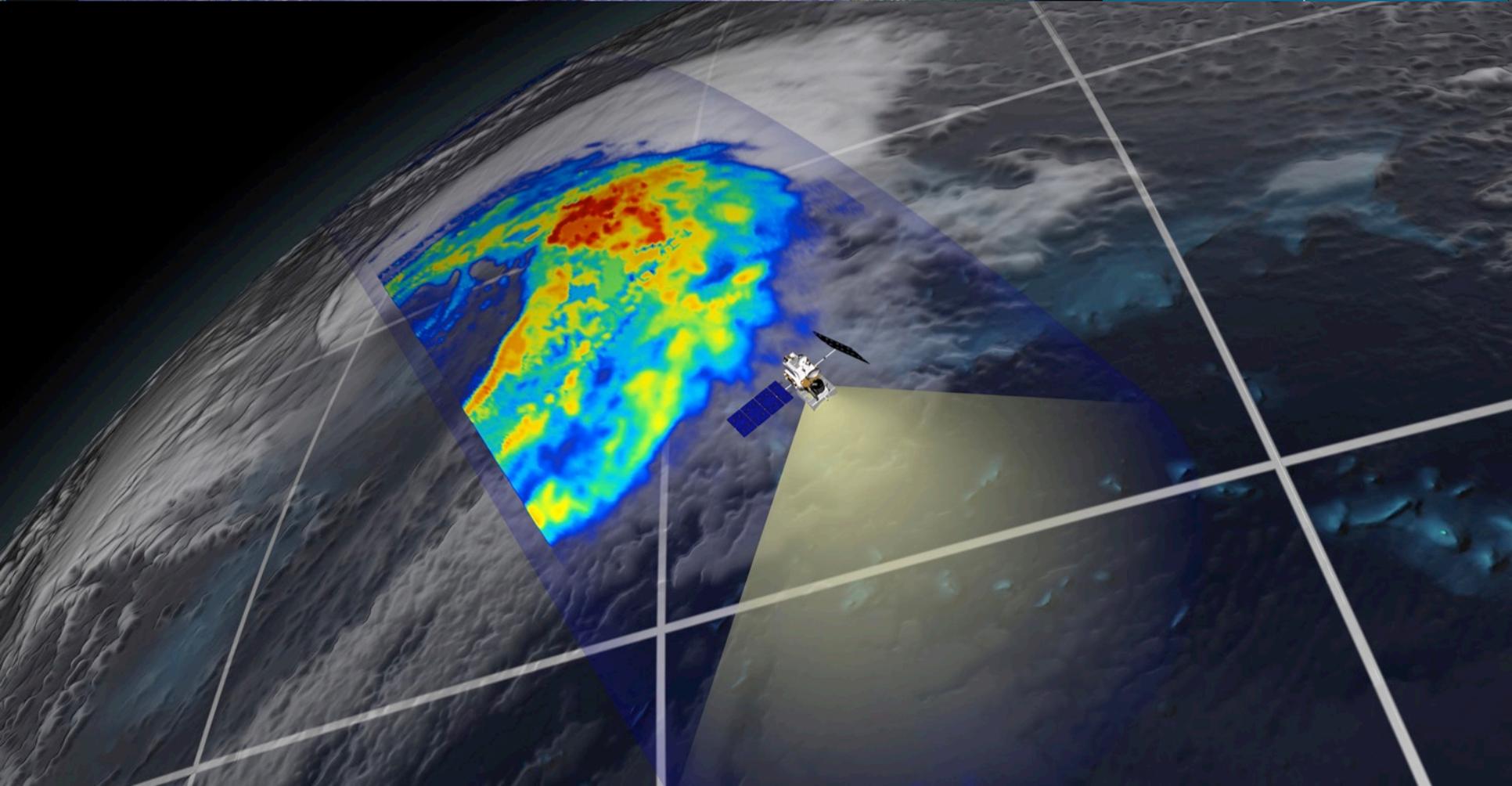
In Development

NOAA - GOES-R, GOES-S, JPSS-1, JPSS-2
USGS - Landsat 9
ICESat-2, PACE
Earth Venture - Instrument
GEDI (ISS)

10 Year Horizon

CarbonHunter, Lidar follow-on to ICESat-2, GEDI, USGS-Landsat 10
Cold atom gravimeter
GPM follow-on; CAPM, PACE, NOAA - GOESS-R series
NOAA - JPSS-3, 4

EARTH SCIENCES



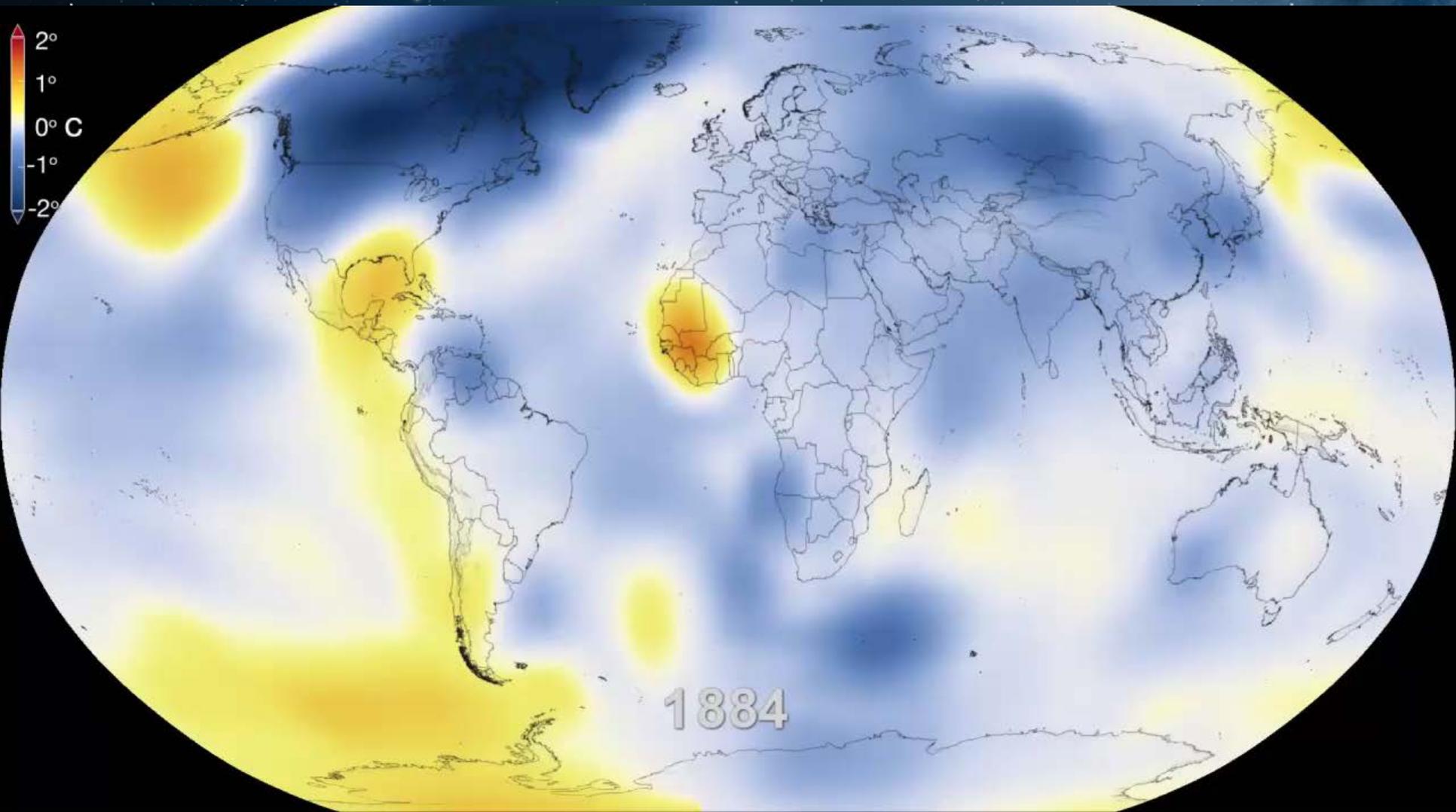
PACE

GEDI

ICESAT-2

GOES-R





Sub-orbital & Aircraft Research Programs



Aircraft, Balloon & sounding Rocket Programs provide important research, excellent science, training experience, and pre-spaceflight demonstration of instrumentation





Goddard Begins and Ends with Science

Fundamental Questions

- How did our solar system form and evolve?
- Can we find evidence of life elsewhere in the solar system?
- What are the different environments and processes in our solar system?

Current Missions

**MAVEN, Cassini
LRO, SAM/Curiosity
Juno, OSIRIS-REx,
GEDI, Voyager**

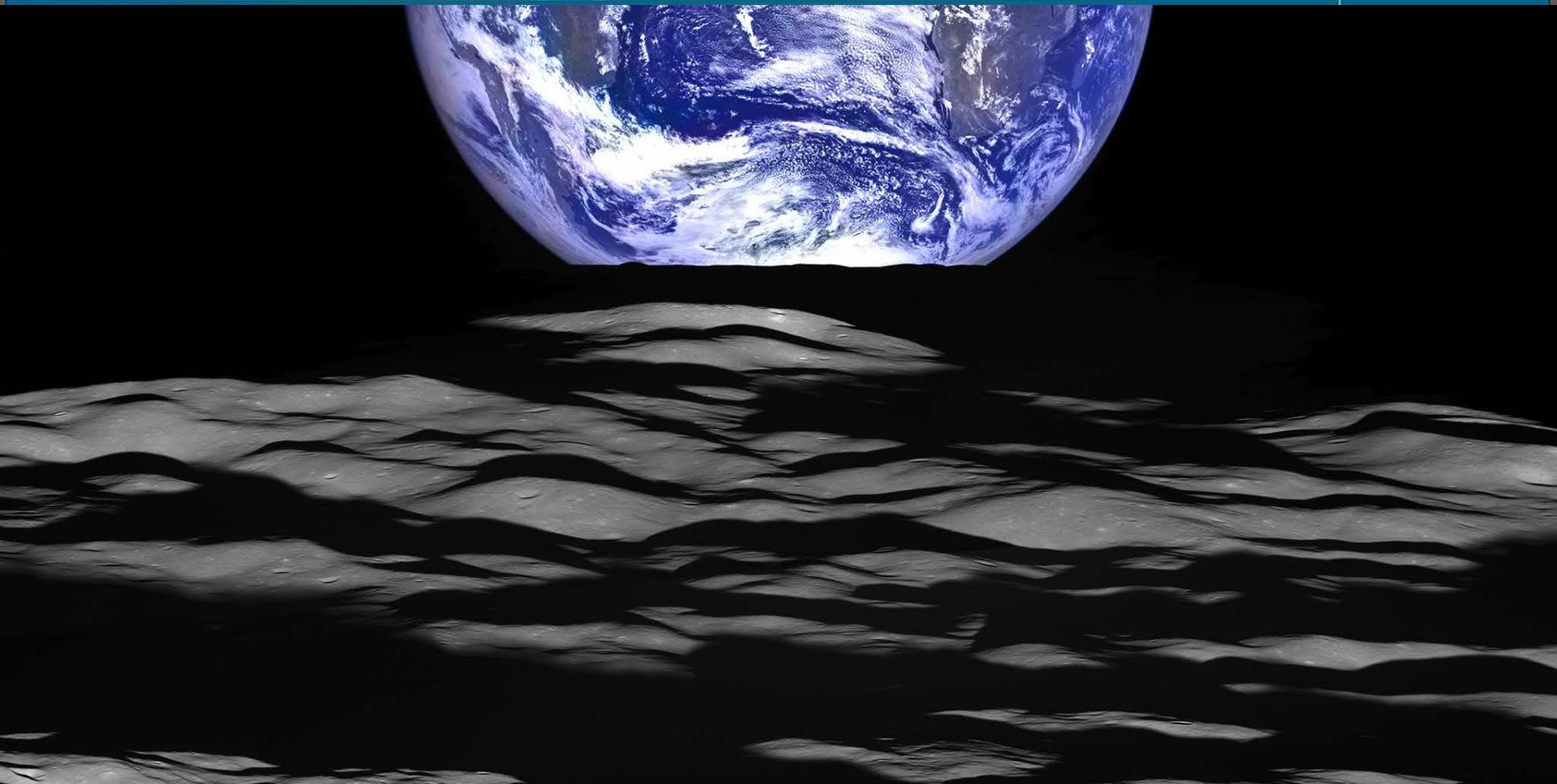
In Development

**DAVINCI –
Venus Atmosphere
LUCY –
Trojan Asteroid Survey
Comet Nucleus-
Sample Return
Venus In Situ Explorer
Trojan Tour and Lander
Enceladus/Titan**

10 Year Horizon

**Plume Life Detection
Mars 2022 orbiter
Mars Sample Return
Korean Lunar Orbiter
Volatile Resources
Europa Lander**

Solar System Exploration





Infrared Spectroscopy (11)



Mass Spectrometry (11)



X-Ray/Gamma Ray (15)



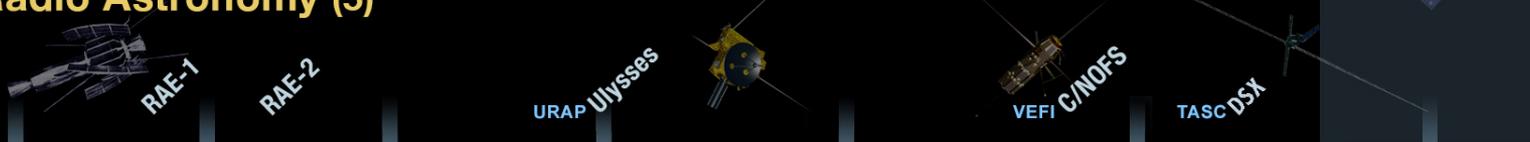
Magnetometry (68)



Laser/LIDAR (9)

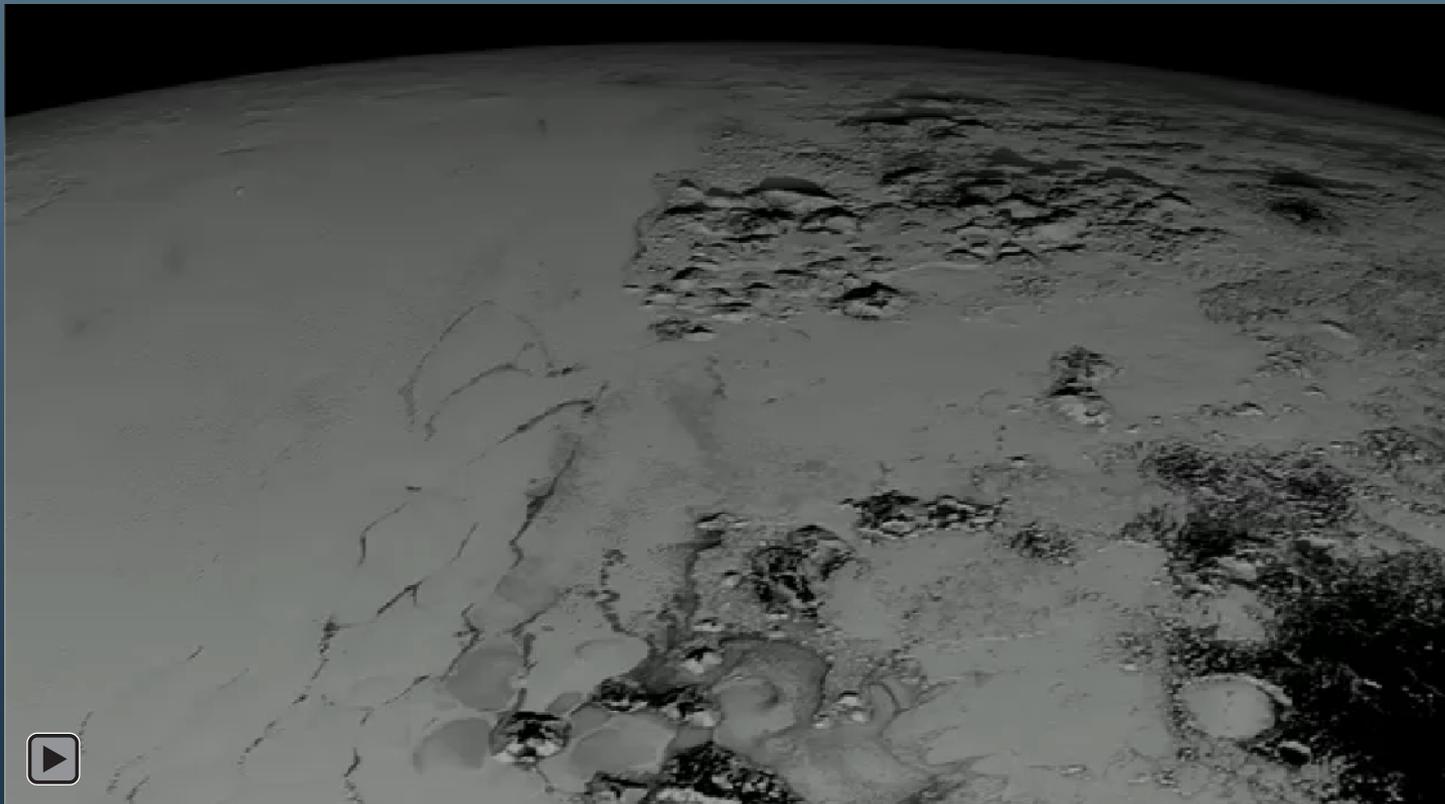
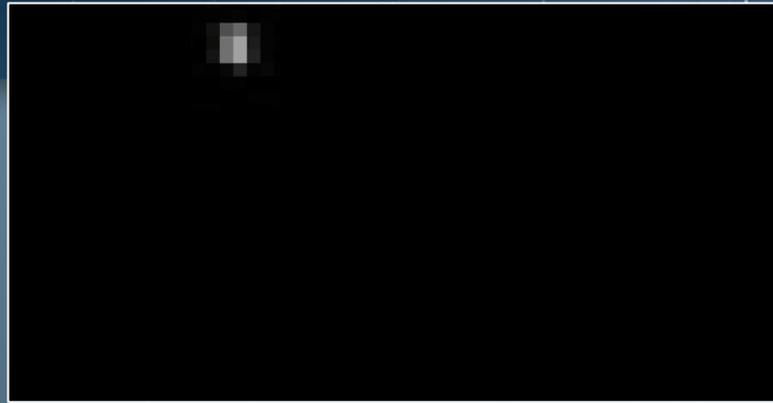


Radio Astronomy (5)



1960 1970 1980 1990 2000 2010 2020

Pluto





Goddard Begins and Ends with Science

Fundamental Questions

- How does the sun work?
- When does space harm us?
- How to live within a star's atmosphere?

HELIOPHYSICS

Current Missions

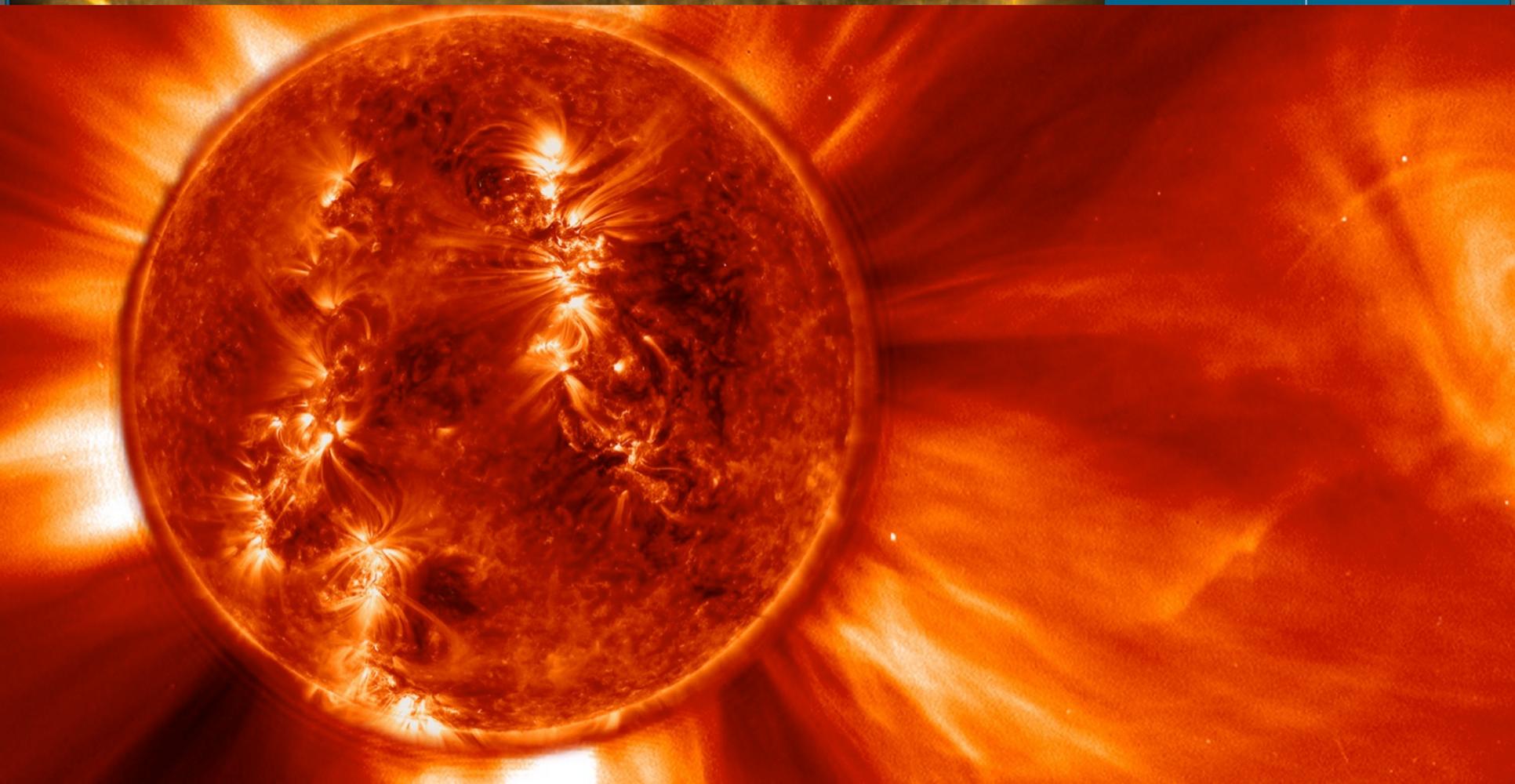
ACE, AIM, ARTEMIS, CINDI Cluster, Geotail, Hinode, IBEX, IRIS, MMS, STEREO, SOHO, SDO, Rhessi, Themis, TIMED, TWINS, Van Allen Probes, Voyager, Wind, and over 20 sounding rocket missions

In Development

SET, GOLD, ICON
Solar Probe +,
Solar Orbiter
STP5, Solar-C, SEE
2020
GEC

10 Year Horizon

Solar Sentinels
MagCon: ~2025
Other MIDE
and SMEX





Outreach: Know your Audience



Outreach: Know your Goals



Reach Largest Group Possible

• Calm Fears Inform Science Community
Create Science Advocates Communicate With Other Agencies Create Excitement About Earth and Space Science

Justify Expenditures Inform Tax Payers of How Money is Used

Teach Increase Funding

Get Media Attention Show Cross Disciplinary Nature of NASA Science



Get to the Point

